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independent conditions (on the scale of most environmental processes), and thus cannot reflect actual rates of performance. Rather, they reflect the potential or probability that functions are performed at a certain level. Model scores based on indicators, therefore, do not reflect the levels at which a function may actually be performed. Instead, they estimate the potential or probability that a function is being performed.

The potential of a wetland to reduce water velocities might be established by using the size and shape of its outlets and the depth of water stored in the wetland as indicators. An indicator of the potential for filtration of sediment might be based on the percent cover of dense erect vegetation near the ground surface. The equation for removing sediments could then be rewritten as:

> *Potential performance = type of outlets + depth of water storage + %cover of different types of vegetation*

In a logic model, the level of performance would be described using conditional phrases such as "the wetland rates high for removing sediments if it has a constricted outlet and an average depth of storage that is greater than 1 m and erect vegetation over more than 80% of its area."

With mechanistic models, the authors choose the variables and scale them based on their judgement. They assign scores to different "states" of a variable (e.g., > 80% cover of emergent vegetation might be given an index of [1]; 40 - 79% cover of emergent vegetation receives an index of [0.5], etc.). Different types of outlets, and different depths of water storage, would also be assigned scaled scores in this manner.

In developing models, the sum of the scores for the variables in an equation are adjusted (normalized) to [1] or [10] for each function. Normalizing is important because each function may have a different number of variables with correspondingly different total sums. The indices of different functions are more easily interpreted if the highest levels are all recorded as a [10].

2.1.4 Scoring Wetlands

Application of a method results in a set of indices, one for each function in each wetland unit being assessed. The indices are presented as a number, for example between 0 and 10, with a 10 representing the highest level of performance.

The index represents an index per hectare or acre of wetland. For example, a small, 1 hectare wetland, and a large 100 hectare wetland may both have an index of [10] for a specific function.An index itself is without any numeric "dimensions".

woody debris in permanent water. **This variable is considered to be a critical habitat component and is weighted by a factor of 2 relative to the other variables.**

Rationale: Overhanging vegetation provides both temperature control and protection from predation. McMahon (1983) reported the need for streamside vegetation for shading. Small coho juveniles tend to be harassed, chased and nipped by larger juveniles unless they stay near the bottom, obscured by rocks or logs (Groot and Margolis, 1994). Cover for salmonids can be provided by overhanging vegetation, submerged vegetation, submerged objects such s logs and rocks, floating debris, deep water, turbulence and turbidity (Giger 1973). Large woody debris plays an important role in Pacific Northwest streams, creating and enhancing fish habitat in streams of all sizes (Bisson et al. 1987).

When juvenile salmonids move into depressional wetlands they will need the same type of cover as found in streams. The Assessment Teams judged that the types of cover found in streams also are necessary in wetlands if the habitat is to be judged as suitable.

Indicators: The presence of overhanging vegetation is characterized during the field visit based on presence/absence of certain characteristics as described in Part 2. Direct measures of the quantity and quality of decaying woody debris is not feasible for a rapid assessment method. A descriptive matrix of different sizes and decay levels of woody debris was developed as an indicator for the variable. The matrix is based on the assessment procedure developed for the TFW watershed assessment methods.

Scaling: AUs with overhanging vegetation and at least 4 categories of large woody debris in permanent exposed water are scored a [1]. AUs with fewer characteristics are scored proportionally, with each type of cover having equal weight (see Calculation Table 6.10.5). AUs with no types of cover are scored a [0].

V_{pow} – The percent of the AU that is covered by permanent open water.

Rationale: AUs that have permanent surface water present provide habitat the entire year rather than just during the wet season. As mentioned in the introduction, the model for depressional outflow wetlands does not have a variable to reflect an absolute requirement for permanent water that would at first seem to be a necessary pre-requisite for fish habitat. AUs with permanent open water, however, provide better habitat than those flooded only seasonally.

Indicators: The variable is assessed by estimating the relative % of the AU that has permanent open water (described in Part 2).

7.1 Potential for Removing Sediment — Depressional Closed Wetlands

Note: Please read the introduction to the assessment models (Chapter 2) before using these models. It describes several basic assumptions used in modeling that will help you better understand how to use and apply the methods.

7.1.1 Definition and Description of Function

Removing sediment is defined as the wetland processes that retain sediment in a wetland, and keep them from going to downgradient surface waters in the watershed.

All depressional closed wetlands have the potential to remove sediment at the highest levels because they have no outlet. All sediments coming into the wetland are retained and not released to surface waters.

7.1.2 Qualitative Rating of Opportunity

The opportunity of AUs in this subclass to remove sediment is a function of the level of disturbance in the landscape. Relatively undisturbed watersheds in the lowlands in western Washington will carry much lower sediment loads than those that have been impacted by development, agriculture, or logging practices (Hartmann et al. 1996, and Reinelt and Horner 1995). The opportunity that an AU has to remove sediment is, therefore, linked to the amount of development, agriculture, or logging present in the upgradient part of its contributing basin.

Users must make a qualitative judgement on the opportunity of the AU to actually trap sediment by considering the land uses in the contributing watershed and the condition of its buffer. The opportunity for an AU in the depressional closed subclass to remove sediments is **"Low"** if most of its contributing watershed is undeveloped, not farmed, or not recently logged. Densely vegetated watersheds (e.g., undisturbed forest) stabilize soils, reduce runoff velocity, and thus export less sediment (Bormann et al. 1974, Chang et al. 1983).

The opportunity is **"Low"** if the AU receives most of its water from sheetflow rather than from an incoming stream, and it has a good vegetated buffer. Vegetated buffers will trap sediments coming from the surrounding landscape before they reach the AU. A buffer that is only 5 m wide will trap up to 50% of the sediment while one that is 100 m wide will trap approximately 80% of the sediments (Desbonnet et al. 1994). The opportunity is also **"Low"** if the AU receives most of its water from groundwater since this source of water does not carry any sediments.

The opportunity for the AU to remove sediments is **"High"** is the contributing watershed is mostly agricultural or there is recent construction or clear-cut logging in it. In contrast to undisturbed watersheds, urban, agricultural, or logged watersheds have more exposed soils

7.5 Potential for Decreasing Downstream Erosion — Depressional Closed Wetlands

Note: Please read the introduction to the assessment models (Chapter 2) before using these models. It describes several basic assumptions used in modeling that will help you better understand how to use and apply the methods.

7.5.1 Definition and Description of Function

Decreasing Downstream Erosion is defined as the wetland processes that decrease erosion of stream channels further downstream in the watershed by reducing the duration of erosive flows.

An AU performs this function if it stores excess runoff during and after storm events, before slowly releasing it to downgradient waters. This is similar to the function provided by stormwater retention/detention (R/D) ponds that are designed to prevent downstream erosion in developed areas. The AU decreases downstream erosion by reducing the duration of erosive flows (erosive flows are the high velocity, high volume flows that cause much of the erosion in a watershed).

The major processes by which wetlands reduce the duration of erosive flows is by storing some of the peak flows and thus reducing the time during which erosive flows occur, and by reducing the velocity of water flowing through the AU during a storm event. Erosive flows in a watershed occur above a certain velocity based on geomorphology. By reducing the velocity in general, an AU can reduce the overall time during which the erosive velocities occur.

The function of decreasing downstream erosion is closely related to that of reducing peak flows because a reduction in peak flows will also result in a reduction of velocity. All of the variables used in the "peak flow" model are used for this function as well. One way to consider the function being assessed is to ask "What would happen to erosive flows in the watershed if the AU were filled?".

7.5.2 Assessing this Function for Depressional Closed Wetlands

All depressional closed wetlands have the potential to decrease downstream erosion at the highest levels because they have no outlet. All floodwaters coming into the wetland are retained and not released to surface waters.

7.5.3 Qualitative Rating of Opportunity

The opportunity for an AU to decrease erosion will increase as the water regime in the upgradient watershed is destabilized. Research in western Washington has shown that peak flows and velocities increase as the percentage of impermeable surface increase (Reinelt and

Scaling: If an AU has 2 or more of the 5 habitat features it is scored a [1]. AUs with one habitat feature score a [0.5] for the variable, and those with none score a [0].

V_{pow} – The percent area of the AU that is covered by permanent open water.

Rationale: Permanent open water provides refuge for many species of waterfowl. The presence of open water allows for the establishment of aquatic vegetation beds, which also provides food for different species of waterfowl.

In addition, open water of varying depths provides greater diversity of foraging habitat for a greater variety of water birds (USDI 1978). Shallow water areas (less than 20 cm deep) provide habitat for rails and teal. The permanent open water should be present throughout the breeding season for maximum functional benefit (Eddelman et al. 1988). To simplify the models the Assessment Teams decided that the variable "permanent open water" is more appropriate than trying to determine whether the water is open during the breeding season. It is understood that some AUs may have open water during the breeding season, but then completely dry up in the late summer. It is too difficult however to establish the presence of open water only during the breeding season.

The extent of the permanent open water required for different scaled scores is based on an educated guess by the Assessment Team, reflecting the need to provide a rapid method. Areas of open water that are smaller than .1 hectare (1/4 acre), or less than 10% of an AU (if it is < 1 hectare), are difficult to determine from aerial photos.

Indicators: The extent of permanent open water in a AU can be easily determined during the dry summer months and no indicator is needed. There is a problem, however, in establishing the size during the wet season when the AU is flooded to its seasonal levels. The indicators that have been suggested to establish the extent of permanent inundation are the edge of emergent vegetation in the deeper portions of a AU, or the presence of aquatic bed vegetation such as *Nuphar spp*.

Scaling: AUs with 30%, or more, of their area covered in permanent open water are scored a [1] for this variable. AUs with a smaller area are scaled proportionally (%open water/30).

$S_{inverts}$ – The habitat suitability index from the Invertebrate function.

Rationale: The index is used to represent the availability of invertebrates as prey for birds.

Indicators: No indicators are needed. The variable is an index from another function.

Scaling: The index is already scaled and re-normalized to 0 –1.

S_{amphib} – Habitat suitability index for the Amphibian function.

Rationale: The index is used to represent the availability of amphibians as prey for birds.

7.11.5 Calculation of Habitat Suitability

Depressional Closed – Habitat Suitability for Wetland-associated Mammals

Variable	Description of Scaling		Score for Variable	Result
Vbuffcond	*Highest:*	Buffer category of 5	If D42 = 5, enter "1"	
	High:	Buffer category of 4	If D42 = 4, enter "0.8"	
	Moderate:	Buffer category of 3	If D42 = 3, enter "0.6"	
	Medium Low:	Buffer category of 2	If D42 = 2, enter "0.4"	
	Low:	Buffer category of 1	If D42 = 1, enter "0.2"	
	Lowest:	Buffer category of 0	If D42 = 0, enter "0"	
Vwaterdepth	*Highest:*	Water depths >1 m present	If D12.3 = 1, enter "1"	
	Moderate:	Water depths between 1-100 cm present	If D12.1 = 1 **and** D12.2 = 1, enter "0.5"	
	Low:	Depths between 1-20 cm present	If D12.1 = 1, enter "0.3"	
	Lowest:	No surface water present	If all D10 are 0, enter "0"	
Vcorridor	*Highest:*	Corridor rating is 3	If D43 = 3, enter "1"	
	Moderate:	Corridor rating is 2	If D43 = 2, enter "0.67"	
	Low:	Corridor rating is 1	If D43 = 1, enter "0.33"	
	Lowest:	Corridor rating is 0	If D43= 0, enter "0"	
Vbrowse	*Highest:*	AU has more than 1 ha (2.5 acres) of preferred woody vegetation for beaver in and within 100 m of AU	If D30 =1, enter "1"	
	Lowest:	Above not present	If D30 = 0, enter "0"	
Vemergent2	*Highest:*	AU has cover of emergent vegetation that is > = 0.4 ha (1 acre)	If (D1 x D14.5)/100 > = 0.4, enter "1"	
	Lowest:	AU has no cover of emergents or emergents < 0.4 ha	If (D1 x D14.5)/100 < 0.4, enter "0"	
Vwintersp2	*Highest:*	If AU is > 0.4 ha (1 acre) and interspersion between vegetation and exposed water is high	If D1 > = 0.4 and D38 = 3, enter "1"	
	Moderate:	If AU > 0.4 ha and interspersion is moderate	If D1 > = 0.4 and D38 = 2, enter "0.67"	
	Low:	If AU > 0.4 ha and interspersion is low	If D1 > = 0.4 and D38 = 1, enter "0.33"	
	Lowest:	AU has < 0.4 ha or AU has no interspersion	If D38 = 0 OR D1 < 0.4, enter "0"	
Vow	*Highest:*	If OW > 0.1 ha (0.25 acres) and OW at least 30% of AU	If (D1 x D8.3) / 100 > 0.1 and D8.3 > = 30, enter "1"	
	High:	If OW > 0.1 ha and OW = 10 - 29% of AU	If (D1 x D8.3) / 100 > 0.1 and 10< = D8.3 < 30, enter "0.8"	
	Lowest:	If OW < = 0.1 ha	If (D1 x D8.3)/100 < 0.1, enter "0"	
	Calculation:	If OW > 0.1 ha scaled as % OW x 0.08	Enter result of calculation	
	If (D1xD8.3)/100 > 0.1 and D8.3 < 10 calculate as D8.3x0.08 to get result			

Table continued on next page

The Assessment Teams recognize that site observations made during the summer will usually result in a higher count of plant species than those that are done during the winter will. This issue is currently unresolved as most of our calibration occurred during the summer and fall. A different scaling may be developed for winter and summer if further data necessitates.

Scaling: If the AU has 30 or more native species it is scored a [1]. AUs with a fewer number of native species are scaled proportionally (# of native species/30).

V_{bogs} – The percent area of the AU is covered by a sphagnum bog (defined as areas where sphagnum mosses represent more than 30% cover of the ground).

Rationale: Sphagnum bogs are often the habitat for many unique plant species (Mitch and Gosselink 1993). These plants are often small and hard to identify. Also sphagnum bogs often lack the physical structure of many other mature wetland plant communities. The presence of bogs is used as an indicator of a potentially very rich native species assemblage that may not be captured by the other variables.

Indicators: No indicators are needed for this variable since the % area of an AU covered by Sphagnum bog can be determined directly.

Scaling: This is an "on/off" variable. AUs with 25% or more Sphagnum bog are scored a [1]. Those with a bog cover <25% are scored a [0].

$V_{nonative}$ – The percent of the AU where non-native species are dominant or co-dominant (non-native species are listed in Part 2, Appendix L) **This is a variable of reduced performance.**

Rationale: The Assessment Teams judged that wetlands where one or more of the dominant species is non-native have lost some of their potential for maintaining native regional plant biodiversity. Non-native plants that become dominant tend to exclude many of the less common native plants.

Indicators: No indicator is needed for this variable. The areal extent of non-native species can be determined in the field.

Scaling: AUs where non-native species extend over more than 75% of the AU have their index reduced by a factor of 0.5. Those with an extent of 50 – 75% are reduced by a factor of 0.7, and those with an extent of non-native between 25-49% are reduced by a factor of 0.9. AUs where non-native species are dominant or co-dominant on less than 25% of the AU do not have their index reduced.

8.8.4 Description and Scaling of Variables

$V_{permflow}$ – Channels or streams are present in an AU and contain permanent flowing water.

Rationale: Permanent flowing water is a habitat feature that supports a unique assemblage of invertebrate species (Needham and Needham 1962, and Wiggins et al. 1980). Invertebrates that are found in permanent flowing channels are an important resource for many other aquatic species (Needham and Needham 1962). The presence of a permanent flowing water is a characteristic whose presence adds to the overall invertebrate richness in an AU.

Streams or channels with intermittent seasonal flow also have the potential for providing a special invertebrate habitat. They are not scaled in the model, however, because it was not possible to determine, in the field, if an intermittent stream or channel is maintained by seasonal flows or by high rainfall events. If an intermittent stream is a result of storm flows, the water does not remain long enough to provide a unique invertebrate habitat.

Indicators: No indicators are needed for this variable because the presence of permanent flow in a channel can be established directly in the summer during the dry season. Indicators for the presence of permanent channel flow in the winter, during the wet season, may be more difficult to establish. Users may have to rely on aerial photographs (usually taken in the summer) or other sources of information to determine if the flows in a channel are permanent.

Scaling: This is an "on/off" variable. An AU scores a [1] if permanent channel flow is present, and a [0] if it is not.

$V_{substrate}$ – The composition of surface layers present in the AU (litter, mineral, organic etc).

Rationale: Not much is known about invertebrate distributions in different substrates within a wetland. Data from rivers, streams, and lakes, however, show that the local invertebrate species have preferences for specific substrate (Dougherty and Morgan 1991, and Gorman and Karr 1978). In streams it is well known that Chironomid community composition is strongly affected by sediment characteristics (McGarrigle 1980, and Minshall 1984). The Assessment Teams assumed that a similar relationship between invertebrate populations and substrates is also found in wetlands. Thus, AUs with different substrates present will provide habitat for a broader group of invertebrates than those with only one type. Moreover, those with organic matter will exhibit greater richness and abundance than those found in sand substrates.

Indicators: No indicators are needed to assess this variable. The number of different substrate types can be determined by direct field observations.

Scaling: AUs with six or more types of substrates of the eight identified (deciduous leaf litter, other plant litter, decomposed organic, exposed cobbles, exposed gravel,

8.11.3 Model at a Glance

Riverine Flow-through — Habitat Suitability for Resident Fish

Process	Variables	Measures or Indicators
Refuge and stream habitat for resident native fish (applies to all variables)	**Vpermflow**	Presence/absence of flow in channel
	Vcover	Categories of refuge present in water
	V%closurest	% length of stream with canopy closure >75%
	Vstreamsubs	Gravel or cobbles present in stream
	Vwaterdepth	Depths of water in permanent stream
	Index:	2 x Vpermflow + Vcover + V%closurest + Vstreamsubs + Vwaterdepth / Score from reference standard site

8.11.4 Description and Scaling of Variables

$V_{permflow}$ – There are channels or streams present in the wetland that have permanently flowing water**. This variable was judged to be a critical habitat feature in riverine flow-through wetlands and is weighted by a factor of 2.**

Rationale: This variable is included for the function because flowing water is an important characteristics for cottids and dace in western Washington (Mongillo pers. comm.).

Indicators: No indicators are needed for this variable in the summer because the presence of flow in a channel can be established directly during the dry season. Indicators for the presence of permanent channel flow in the winter, during the wet season, may be more difficult to establish. Users may have to rely on aerial photographs (usually taken in the summer) or other sources of information to determine if the flows in a channel are permanent.

Scaling: This is an "on/off" variable. An AU scores a [2] if permanent channel flow is present, and a [0] if it is not.

V_{cover} – Structures in the AU that provide cover in and over water. This variable is assessed based on three structural elements: 1) vegetation that overhangs permanent water; 2) undercut banks; and 3) large woody debris in permanent water.

Rationale: Refuge from predators is an important habitat feature for maintaining successful fish populations, and wetlands that provide such refuge have a higher potential of performing than those that do not. Overhanging vegetation and undercut banks provide both temperature control and protection from predation. Large woody

Scaling: AUs with 10%, or more, of their area covered in permanent open water (i.e. stream) are scored a [1] for this variable. AUs with a smaller area are scaled proportionally (%open water/10).

S_{inverts} – The habitat suitability index from the Invertebrate function.

Rationale: The index is used to represent the availability of invertebrates as prey for birds.

Indicators:_ No indicators are needed. The variable is a index from another function.

Scaling: The index is already scaled between 0 –10, and is re-normalized to a range of 0 - 1.

S_{amphib} – Habitat suitability index for the "amphibian" function.

Rationale: The index is used to represent the availability of amphibians as prey for birds.

Indicators: No indicators are needed. The variable is a index from another function.

Scaling: The index is scaled between 0 –10, and is re-normalized to a range of 0 – 1.

S_{fish} – Habitat suitability index for the Fish function. The assessment methods have two functions to characterize habitat suitability for fish (anadromous and resident). The higher of the two scores is used in this model.

Rationale: The index is used to represent the availability of fish as prey for birds.

Indicators:_ No indicators are needed. The variable is a index from another function.

Scaling: The index is scaled between 0 –10, and is re-normalized to a range of 0 – 1.

$V_{effectarea2}$ – Areal extent of the AU (as a % of total) that undergoes changes between oxic and anoxic conditions.

Rationale: Nitrogen transformation occurs in areas of the AU that undergo changes between oxic and anoxic regimes. The oxic regime is needed to change ammonium ions (NH_4^+) to nitrate, and the anoxic regime is needed for denitrification by bacteria (changing nitrate to nitrogen gas) (Mitsch and Gosselink 1993).

Indicators: The indicator for the zone where oxygen saturation changes is the annually inundated area minus the area of permanent inundation (area of seasonal inundation). The assumption for using this indicator is that areas that are seasonally inundated are saturated for a long enough period to develop anoxic conditions and thus denitrification. The seasonal drying then re-introduces oxic conditions that promote nitrification. The area that is permanently inundated, however, is not expected to have enough oxygen at the surface to promote nitrification.

Scaling: AUs that are completely inundated seasonally, and have no permanent exposed water, are scored a [1] for this variable. Scaling for the others is proportional, based on the % area that is only seasonally inundated (%area / 100).

V_{out} – The amount of constriction in the surface outflow from the AU.

Rationale: Water will tend to be held longer in an AU if its outlet is constricted regardless of its internal structure (Adamus et al. 1991). The constriction is judged to increase the residence time and permit a longer period for the denitrification to occur in the AU. NOTE: V_{out} is also a variable in the "removing sediments" model. It is used again here because in Ssed is used only to model the removal of phosphorus. Since it is also important in the removal of nitrogen it is used again to model the latter process.

Indicators: No indicators are needed. The relative constriction of the outlet is determined in the field.

Scaling: The scaling of this variable is based on the amount of constriction found in the AU.

Unconstricted or slightly constricted – Unconstricted or slightly constricted outlets are scored a [0].

Moderately constricted – Moderately constricted outlets are scored a [0.5].

Severely constricted –Severely constricted outlets are scored a [1].

No outlet - No outlets are scaled as [1].

Rationale: The variable is a measure of the relative capacity of the outlet to impound water and store it temporarily during a flood event. This reduces the velocity of water downstream of the AU. AUs that have constricted outlets due to undersized road culverts or narrow outlets hold water longer than a flooding event and will therefore reduce the duration of erosive flows. Water velocities and flows out of an AU will be reduced if its outlet is constricted regardless of its internal structure (Adamus et al. 1991).

Indicators: No indicators are needed. The relative constriction of the outlet is determined in the field.

Scaling: The scaling of this variable is based on the amount of constriction found in the AU.

Unconstricted or slightly constricted – Unconstricted or slightly constricted outlets are scored a [0].

Moderately constricted – Moderately constricted outlets are scored a [0.5].

Severely constricted – Severely constricted outlets are scored a [0.8].

No outlet – No outlets are scaled as [1].

$V_{woodyveg}$ – The areal extent (as a % of the AU) of woody vegetation present that will reduce water velocities during a flood.

Rationale: Surface water flowing through areas of woody vegetation will have its velocity reduced because the stiff vegetation provides a structural barrier to flow (Adamus et al. 1991). The extent of the woody vegetation over the entire AU is used because the vegetation can also reduce velocities of water coming in as sheetflow in areas that are not inundated by flooding.

Indicators: The indicator for stiff erect vegetation is the percent area within the AU of two Cowardin vegetation classes – forest and scrub/shrub. The Assessment Team judged that these two classes represent vegetation that will remain erect during a flood event and will provide the structural barrier needed to reduce velocities.

Scaling: AUs that have a 100% cover of forest or scrub/shrub are scored a [1] for this variable. Scaling for the others is proportional, based on the % area that is covered by forest and/or scrub/shrub (% area / 100).

$V_{inund/shed}$ – The ratio of the area that is annually ponded or inundated with the AU to the area of its contributing basin. **This variable was judged to be more important than the others in the equation and was given a weighting factor of 2.**

Rationale: The potential of an AU to reduce velocity is partially a function of the retention time of water in the wetland during a storm event. Retention time is the relative volume coming into a unit during a storm event divided the amount of storage present. The area of the contributing basin is used as a surrogate for the relative amount of water (volume as cubic meters/second) entering the AU, while the area of to be the area that is seasonally inundated (area that is permanently inundated is excluded from this variable).

Indicators: The indicator for the effective area is the annually inundated area minus the area of permanent inundation.

Scaling: AUs that are completely inundated annually and have no permanent exposed water are scored a [1] for this variable. Scaling for the others is proportional, based on the % area that is only seasonally inundated (%area / 100).

Indicators: The variable is characterized using a condensed form of the depth classes first developed for WET habitat assessments (Adamus et al. 1987). These are 0-20 cm, 20-100 cm, and > 100 cm.

Scaling: AUs with all three depth classes present are scored a [1]. Those with the two shallower ones are scored a [0.5]; those with 0-20 cm of water are scored a [0.1]. AUs with no permanent or seasonal inundation are scored a [0]. In some cases an AU may have steep sides. If the water depth is greater than 100 cm but the AU does not have enough shallow water to meet the size requirements (0.1 ha or 10%, whichever is the smaller) it is scored a [0.7].

V_{cover} – Structures in the AU that provide cover in and over water. This variable is assessed based on three structural elements: 1) vegetation that overhangs permanent water; 2) undercut banks; and 3) large woody debris in permanent water.

Rationale: Refuge from predators is an important habitat feature for maintaining successful fish populations, and wetlands that provide such refuge have a higher potential of performing than those that do not. Overhanging vegetation and undercut banks provide both temperature control and protection from predation. Large woody debris plays an important role in the Pacific Northwest, creating and enhancing fish habitat (Bisson et al. 1987).

Indicators: The presence of overhanging vegetation and undercut banks is characterized during the field visit based on presence/absence of certain characteristics as described in Part 2. Direct measures of the quantity and quality of decaying woody debris is not feasible for a rapid assessment method. A descriptive matrix of different sizes and decay levels of woody debris was developed as an indicator for the variable. The matrix is based on the assessment procedure developed for the TFW watershed assessment methods.

Scaling: AUs with both overhanging vegetation and undercut banks, and at least 6 categories of large woody debris are scored a [1]. AUs with fewer characteristics are scored proportionally, with each type of cover having a different weight (see Calculation Table 9.11.5). Large woody debris is weighted by a factor of 3 and undercut banks by a factor of 2 relative to overhanging vegetation. AUs with no types of cover are scored a [0].

V_{pow} – The percent of the AU that is covered by permanent open water.

Rationale: Ponded surface water is needed for fish. Wetlands that have permanent surface water present provide habitat the entire year rather than just during the wet season, thereby increasing the suitability of the AU as habitat.

Indicators: The variable is assessed by estimating the relative % of the AU that has permanent open water (Part 2).

Scaling: AUs that have 30% or more permanent open water are scored a [1]. Those with less are scored proportionally (%pow/30).

Scaling: If the AU is greater than 6 ha, the variable is scored a [1]. Smaller AUs with buffers that are vegetated with relatively undisturbed vegetation of at least 100 m around 95% of the AU (buffer category #5) are scored a [1]. The categories between 0-5 are scaled proportionally as 0, 0.2,0.4, 0.6, and 0.8 respectively. **The size threshold is included so large wetlands are not penalized for having poor buffers**.

V_{snags} – The number of different categories of snags, based on decomposition states, found in the AU.

Rationale: Snags are a source of cavities and perches for wetland-associated birds. Several species of birds utilize already existing cavities for nesting and/or refuge locations. The presence of cavities in standing trees can indicate the relative age or maturity of the trees within the AU, and therefore the structural complexity present. Dead wood attracts invertebrates and other organisms of decay, which in turn provide a food source for many species of birds (Davis et al. 1983).

Indicators: The number and size of cavities in an AU cannot be measured directly because they may be difficult to count and measure. Eight different categories of snags representing different levels of decay are used as the indicator for the different potential sizes of cavities. It is assumed that cavities will form or be excavated if dead branches or trunks are present.

Scaling: If a riverine impounding AU has 6 or more of the 8 categories of snags present it scored a [1]. Fewer categories are scaled as proportional to 6 (i.e. # of categories/6).

$V_{vegintersp}$ – The relative interspersion between Cowardin vegetation classes (Cowardin et al. 1979).

Rationale: Vegetation interspersion is the relative position of plant types to one another. As an example, an AU may have an emergent marsh of cattails; a nearby shrub/swamp of willows; and an adjacent area of alder swamp. This AU contains three Cowardin classes - emergent, shrub, and forest. For some bird species, this is irrelevant, as many species are single habitat type users. Other species, though, may require several habitat types to being close proximity to aid their movements from one type to another (Gibbs 1991, Hunter 1996).

Indicators: The amount of interspersion between vegetation classes is assessed using diagrams developed from those found in the Washington State Rating System (WDOE 1993).

Scaling: AUs with more interspersion between vegetation classes score higher than those with fewer. The method has four categories of interspersion (none, low, moderate, high) and these are used as the basis for developing a scaled score. A high level of interspersion is scored a 1, a moderate a 0.67, a low = 0.33, and none = 0.

$V_{edgestruc}$ – The vertical structure and linear characteristics of the AU edge.

Rationale: The configuration (e.g., length of shoreline in relation to area) and differences in vegetation strata along the edge of the AU are important habitat characteristics for many species of wetland-associated birds. Additional habitat exists within vegetated lobes and scalloped edges of AUs with differences in edge strata and the shape of the AU edge.

For example, a simple AU may be a nearly circular pond with a fringing emergent marsh composed of cattails, which adjoin immediately to an upland of grazed pasture. The edge of the AU in this case is characterized as having low structural complexity (lack of shrubs and trees), and low linear complexity (as the edge is nearly circular, with no embayments or peninsulas). In contrast, a more complex AU may adjoin with an upland composed of trees and shrubs, adding to the structural complexity, and may be irregular along the edge, with many twists and turns, resulting in enclosed bays and jutting peninsulas. Further, embayments and peninsulas provide "micro-habitats" for certain species that require hiding cover, or "feel" more secure within a more enclosed system (USDI 1978, Verner et al. 1986, and WDOE 1993).

Indicators: The structure of the AU/upland edge is assessed by using a descriptive key that groups the edges and vertical structure along the edge into "high" structural complexity, medium, low, and none.

Scaling: AUs with a high structural complexity at the edge are scored a [1]; moderate = 0.67, low = 0.33, and none = 0.

$V_{spechab}$ – Special habitat features that are needed or used by aquatic birds. Five different habitat characteristics are combined in one variable. These are:

1) the AU is within 8 km (5 mi) of a brackish or salt water estuary;
2) the AU is within 1.6 km (1 mi) of a lake larger than 8 ha (20 acres);
3) the AU is within 5 km (3 mi) or an open field greater than 16 ha (40 acres);
4) the AU has upland islands of at leas 10 square meters (108 square feet) surrounded by open water (the island should have enough vegetation to provide cover for nesting aquatic birds); and
5) the AU has unvegetated mudflats.

Rationale: The suitability of an AU as habitat for aquatic birds is increased by a number of special conditions. Specifically, the proximity of an AU to open water or large fields increases its utility to migrant and wintering waterfowl. If there is strong connectivity between relatively undisturbed aquatic areas the suitability as habitat is higher (Gibbs et al. 1991, Verner et al. 1986). In addition, islands surrounded by open water provide a protected nesting area for ducks if they have adequate cover. Mudflats are an important feeding area for migrating birds.

Indicators: No indicators are needed for this variable because the presence of the special habitat features can be determined on site, from maps, or aerial photos.

Scaling: If an AU has 2 or more of the 5 habitat features it is scored a [1]. AUs with one habitat feature score a [0.5] for the variable, and those with none score a [0].

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